CSCE 439/839: Robotics
Homework 2

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Started: Thursday, October 10, 2013
Due: 5pm Friday, October 25th, 2013

Instructions: This homework is an individual assignment, collaboration is not allowed. If you discuss any problems with others, please note this on the assignment as described in the syllabus. Also note any materials outside of lecture notes, course textbooks, and datasheets that you used. Answer all questions with **complete sentences** and describe your reasoning where appropriate for full credit. This homework is due on the date listed above before the start of class.

You should also make sure that you properly label and **describe** any figures or plots that you include in your writeup. You will not receive full credit if you do not explain these. In addition, while you do not need to turn in a printout of your code for this assignment (instead you should submit via handin), you should refer to your code where needed to answer the questions (e.g. say "See file mynode/launch/test.launch for this problem, which ...").

You must bring a printout (typed, not hand written) of your assignment class on the day it is due! Make sure to answer questions in complete sentences and explain answers as needed. **You must also turn in your code for all parts of this problem and a PDF version of your report by visiting** `http://cse.unl.edu/~cse439/handin/`. Failing to electronically turn in your code (and PDF) will result in a 10 point penalty on this assignment. Points may also be deducted for coding errors, poor style, or poor commenting.

Name:

Problem 1. *Hovercraft*

a) (5pts)**.** *What are the requirements for a robot to be omnidirectional?*

b) (5pts)**.** *With uni-directional thrusters (as ours are) what is the minimum number of thrusters needed to create an omni-directional hovercraft that is also able to rotate either direction in the x-axis? What if the thrusters are bi-directional? Explain.*

c) (5pts)**.** *What are two problems that may occur if the center of mass of your hovercraft is not centered on the vehicle?*

d) (5pts)**.** *How much* **current** *do the processors on the hoverboard use when the thrusters are not running. How much* **power** *does one thruster set at 0.5 require? Include a plot of the current over time for both of these. (Hint: there are ROS topics that gives information on these.)*

Problem 2. *ROS: In this problem, you will create a ROS node that will compute statistics for the Huskers' Football team. For these questions, refer to the hw2 code, especially the* `rawStats` *node that defines and publishes a message of type* `offensivePlay` *on the topic* `/plays/huskerOffensivePlay`*.*

a) (5pts)**.** *What ROS command-line command do you use to create a new node, called* `offensiveStats` *that is written in C++ or Python and is able to subscribe to messages of type* `offensivePlay`*?*

b) (5pts)**.** *Write the code in this node to compute the pass completion percentage (number completed passes divided by total number of passes attempted).*

c) (5pts)**.** *Create a new message type that contains the pass completion percentage as well as the total passing and rushing (non-passing yards gained) yards for this game. How do you ensure that this message is compiled when you run rosmake?*

d) (5pts)**.** *Write the code to create a publisher, populate, and send the above message. Make sure to comment your code.*

e) (5pts)**.** *What command would you use to plot the total yards completed? Give the command, the proper arguments, and include the plot.*

f) (5pts)**.** *Without changing the* `rawStats` *node, launch a new pair of nodes that publish raw stats on the topic* `\plays\opponentOffensivePlay` *and also generates the offensive stats for the opponent. Hint: look into "remap" in the ros documentation.*

g) (5pts)**.** *Create a launch file that will launch all four nodes.*

Problem 3. *Sensing*

a) (5pts)**.** *What is the difference between precision and accuracy? Which is more important for the gyroscope on the hovercraft? Why?*

b) (5pts)**.** *How do you get position information from an accelerometer? What would the position error be if the accelerometer has a 2% error after moving 50 meters?*

c) (5pts)**. 839 Only:** *The gyro on the hovercraft tends to drift. What additional sensor(s) could you add to the hovercraft to correct for this drift. How would this work?*

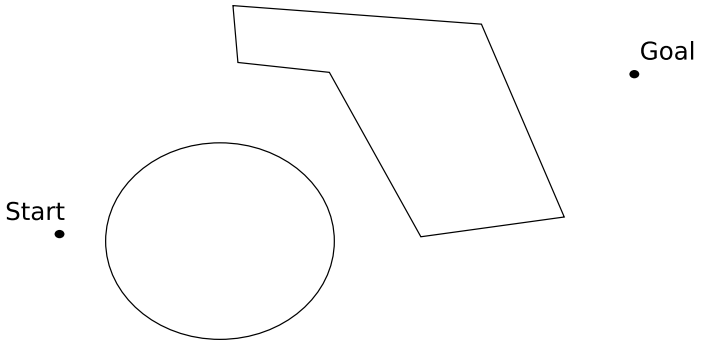

Figure 1: Bug algorithms

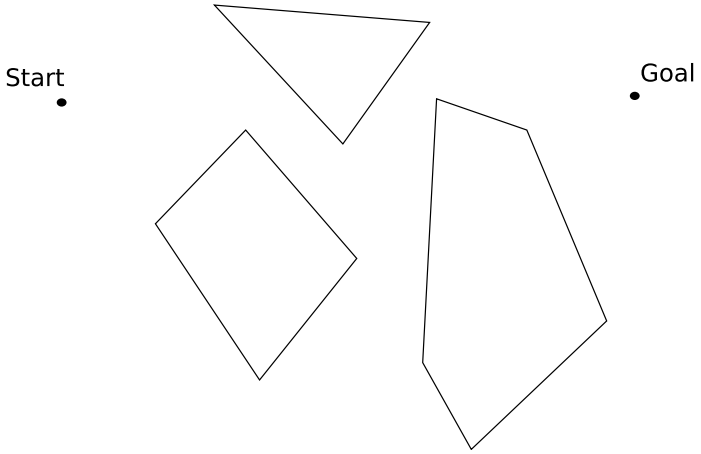

Figure 2: Visibility Graph

Problem 4. *Path Planning*

a) (5pts)**.** *In Figure 1, draw the path the Bug1 algorithm would take. Explain the algorithm.*

b) (5pts)**.** *Draw the visibility graph for Figure 2 and indicate the path that the robot follow from the start to the goal. Explain.*

c) (5pts)**. 839 Only:** *In Figure 1, draw the path Tangent Bug would take (in a different color/style line or on a separte plot). Explain the algorithm.*

d) (5pts)**. 839 Only:** *In Figure 1, one of the Bug algorithms outperformed the other. Draw a different figure where the performance is reversed. Explain what happens.*

Problem 5. *PID*

a) (5pts)**.** *Write the equations for a PID controller and explain the impact of each of the P, I, and D terms.*

b) (5pts)**.** *In a controller running at 10Hz with P=10, I=0.1, and D=4 (without any loop time compensation), what would you set the parameters to if the loop rate was increased to 20Hz? Why?*

c) (5pts)**. 839 Only:** *List and explain 2 different problems that can occur with PID controllers and how you can mitigate these problems in a PID controller.*

Problem 6 (5pts)**.** *Which question took the most time on this assignment?*

Problem 7 (5pts)**.** *Approximately how much time did the total assignment take?*